but a real cost for the unaffiliated company. So long as the competitive wireless companies send more traffic to the local exchange company than they receive from it (as is generally the case), then a high mutual compensation rate disadvantages the non-affiliated carriers and could make it impossible for them to compete with the affiliated carrier. Thus if the monopolist of part of the market is not restricted in its ability to enter potentially competitive sectors of the market, mutual compensation without control of rates fails to provide the consumer benefits of competition.

C. Mutual Compensation at Cost

In this case, each party must compensate the other at identical rates, but the rates are limited to the actual cost of providing terminating service. Using the model developed above, the compensation rate for termination service in this case would be $.50 per call.

The competitors of B will provide BB traffic at the competitive price of $1.00. They will also provide BA traffic at the competitive price of $1.00, composed of $.50 incurred as their own cost for originating traffic and $.50 incurred as an access payment for terminating traffic. The monopolized customers of A will pay the monopoly price of $2.00 per call for AA traffic and will pay the monopoly price of $2.00 per call for AB traffic.

With cost-based interconnection charges, the opening up of 50 percent of the customers to potential competition reduces monopoly power by 50 percent. This contrasts with the case of mutual compensation without control of rates in which the monopoly power was only reduced by 20 percent. The cost-based interconnection effectively eliminates the network externality and makes the telephone network similar to a standard market. The two "products" of service to A and service to B can be sold separately in accordance with their respective market conditions. The cost based interconnection effectively severs the tie between the products, and removes it from the context of network externalities, vertical integration, or tightly complementary products.

The use of cost based interconnection also makes the monopoly power and actions of A very visible. In the preceding case, the customers of A and B were charged the same price, leaving some potential doubt as to whether A was truly exerting its monopoly power. In this case, the customers of A are charged twice the rate of the customers of B even for the same physical call and therefore the monopoly actions of A are clear.

IV. Fixed costs per subscriber

Assume a fixed cost of $2 per subscriber. That is, any company that chooses to serve a particular subscriber incurs a cost of $2 even with no traffic, and incurs the same costs as above ($.50 originating and $.50 terminating) for each call carried. Fixed costs per subscriber have been a standard part of telecommunication history, and many of the existing universal service provisions are concerned with defraying the fixed costs per subscriber. In telephone language, the previous section assumes non traffic sensitive (NTS) costs are zero and this section assumes NTS costs are significant.

A. No Required Interconnection

With no required interconnection, a company choosing to serve the potentially competitive customers in set B can only be certain of the BB traffic (the traffic among customers of B). A separate network to serve only BB calls at a price of $1 per call as in the previous section is no longer viable because of the fixed cost per subscriber. A company desiring to serve only BB traffic must charge enough to pay the fixed cost of $2 per subscriber as well as the usage cost of $1 per call. The only way to do that with linear pricing is to charge the BB customers the monopoly usage price of $2 per call, yielding a profit above usage costs of $2 per person which is just enough to cover the fixed cost of serving the person. That provides no advantage to customers of BB compared to accepting service from the monopoly and therefore the separate network for BB customers alone is not feasible.

So long as interconnection is not required and the monopolist of A recognizes that service to BB alone is not viable, the monopolist of A will refuse connections. That allows A to monopolize the entire market. A's ability to extend its monopoly power from AA and AB traffic to include BA traffic in the case of no fixed costs now allows A to extend its market power to BB traffic as well.

Alternatively, A can accomplish the same thing as refusing to interconnect by setting a high fee for interconnection. If A charges $1.50 for traffic terminating on its network, customers of B are indifferent between taking service from A or from B and A makes a profit of $1 per call either directly from the customer or from the interconnection fees charged to B. The difference from the previous case is that A can now also make a profit of $1 per call from BB calls because it is infeasible to pay the additional fixed cost of having a separate network only for BB calls. The combination of fixed costs and no interconnection requirements means that the potential competition for half of the customers does not reduce total monopoly power at all. The customers pay full monopoly prices for all calls, just as if there were no possibility of entry for any customers. Total potential monopoly profits are less in this case than before because of the fixed cost per subscriber. The potential monopoly profits of $30 in the previous case are reduced by $12 (fixed cost of $2 per subscriber times 6 subscribers) to $18. However, the monopolist of A now makes 100 percent of the potential monopoly profits rather than 80 percent as in the previous case.

B. Required interconnection with mutual compensation

A will demand a high rate (above $1.50 per call) as a termination fee for any traffic received from B and will agree to pay the same rate for any traffic sent to a company serving B. However, A will also establish an affiliate in B and will send as much traffic as possible to its own affiliate. As in the case of no fixed cost, this transfers profit from the monopolist of A to A's affiliate serving B customers, but it does not reduce prices for customers or reduce total monopoly power. Because of the fixed costs per subscriber, no company independent of the monopolist of A will find it profitable to serve any part of the B market. The interconnection fee established by A makes it unprofitable to serve B customers without return traffic, and unaffiliated companies serving B cannot be certain of the amount of return traffic they will receive. The fact that unaffiliated companies see the interconnection fee as a real cost while the affiliated company only sees it as a transfer payment among parts of the company allows A to manipulate the fee to disadvantage its competitors. Thus even with half of the market open to competition and required interconnection with mutual compensation, A can monopolize the entire market by controlling the level of the interconnection fee.

As in the case of no fixed costs, the key issue in this case is that A is able to establish an affiliate to serve B, but competitors in B are not able to establish an affiliate to serve A. Consequently, A and its affiliate can pay any necessary fee to each other and recognize the profit in whichever place is convenient. So long as A can establish an affiliate in B, there is no difference between the case of required interconnection with mutual compensation and the case of no required interconnection. In both cases, the monopolist of A can entirely monopolize the market.

C. Mutual Compensation at Cost

With cost-based mutual compensation, the monopolist of A is no longer able to extend its monopoly power into the B market. As in the case of no fixed cost, cost-based mutual compensation allows the customers of BB and BA to enjoy competitive prices. The monopolist of A cannot artificially raise the price of BB or BA traffic by setting a high mutual compensation rate and transferring profits to an affiliate. Cost-based mutual compensation achieves the theoretical ideal of restricting monopoly power to the set of customers for which there are no alternatives and preventing the extension of monopoly power to potentially competitive markets through manipulation of interconnection compensation. With cost-based mutual interconnection, the opportunity for competition among half of the customers reduces total monopoly power in half. That contrasts with the case of mutual compensation without restrictions on the rate charged in which the opportunity for competition among half of the customers did not reduce monopoly power at all.

V. Practical Considerations in Designing an Interconnection Policy

Both existing policy toward international settlement rates and theoretical analysis support the goal of cost based compensation rates for jointly provided services. In the above examples, cost was a simple constant rate per minute. Unfortunately, the real world is not so simple and the actual definition and measurement of cost require care. For example, most telecommunication equipment is engineered for peak period usage. Because most of the cost of service is related to the capacity of the plant rather than the actual number of minutes used, the true cost for peak period usage is much greater than the cost for off peak usage. The cost of carrying off-peak traffic may be very near zero. Any interconnection policy should provide feasible administrative and measurement mechanisms and should provide maximum freedom for innovations in service and pricing. Two practical approaches to the general principle of cost based mutual compensation should be considered.

A. Sender keep all

A particularly simple approach to mutual compensation is sender keep all. Under this arrangement, each company is obligated to terminate traffic for other companies and is entitled to have its traffic terminated by other companies. Each company bills its customers for its originating traffic and pays no compensation to any other company for terminating service.

Sender keep all is mutual compensation with the price of terminating service set at zero. It is economically efficient so long as the real cost of providing terminating service is low. The incentives for manipulation are reversed in this case compared to the previous cases of above-cost terminating rates. Under sender keep all, each company has an incentive to increase the efficiency of its operations in order to reduce its costs and to maximize its outgoing traffic relative to its incoming traffic because outgoing traffic is the most profitable.

Although sender keep all departs from the theoretical goal of cost based compensation by setting a below cost price for terminating service, there is less opportunity for manipulation than with the price of terminating service above cost. If traffic is balanced, the price is irrelevant. Decreasing the incentives for traffic manipulation will tend to increase the balance of the traffic and reduce the significance of the difference between cost and the zero compensation rate. With mutual compensation rates above cost, the monopolist has an incentive to send as much traffic as possible to its own affiliate and as little traffic as possible to the competitors of its affiliate. With sender keep all, the monopolist has no incentive to send traffic to an affiliate. The monopolist does have an incentive to refuse to accept terminating traffic, but the interconnection requirement implies an obligation to terminate any traffic that is presented.

B. Peak Usage Measurement

The recent NYNEX-Teleport interconnection arrangement provides an example of a combination of usage charges and sender keep all arrangements. The general form of the agreement is to establish a particular charge for a two-way channel of given capacity between the two companies. Traffic is measured at the busy hour each month and the relative measurements are used as an allocation factor for the established channel rate. If traffic is exactly balanced, the payments to each company cancel out and the level of the established rate is irrelevant. If traffic is not balanced, and if Teleport, for example, sends more traffic to NYNEX than it receives from NYNEX at the busy hour, that imbalance is used to compute a net payment from Teleport to NYNEX.

The agreement is essentially a sender keep all arrangement for non-peak traffic. = 0
Because relative traffic is only measured at the peak hour, either company can increase its traffic to the other at non-peak times without affecting the charges due. For peak traffic, the agreement is essentially a per minute compensation scheme. An increase in peak period traffic from NYNEX to Teleport, for example, without a corresponding increase in the other direction, changes the financial flows between the companies in the same way that a per minute charge for peak terminating traffic would do.

The distinction between peak and off-peak traffic is beneficial for administrative simplicity and for economic efficiency. Costs are generally associated with peak traffic and therefore the effectively zero charge for terminating off-peak traffic is cost based.

While the structure of the NYNEX-Teleport agreement is beneficial for equating termination charges to cost during the off-peak period, it does not in itself solve the problem of increasing market power through high charges discussed in the previous sections. If the established price for a channel of given capacity is set far above cost, then the company with market power could engage in the same kind of manipulation discussed above. For example, with a very high priced channel, NYNEX could choose to not terminate traffic through Teleport during the peak hour while Teleport would have little choice but to terminate traffic through NYNEX. That could cause Teleport to pay rates for termination that were high enough to reduce the benefits of competition.

If the established price for a channel of given capacity is near the real cost, then the NYNEX-Teleport arrangement provides an attractive model for general interconnection issues. It would approach a cost-based interconnection fee for both peak and off peak traffic, leading to economic efficiency and opportunities for pricing innovations.

VI. Conclusion

When the market is composed of segments that are monopolized and segments subject to competition, interconnection and compensation arrangements are critical to the development of effective competition. A good interconnection policy will allow effective competition in the potentially competitive segments of the market while a poor interconnection policy will allow the monopolist of part of the market to extend its monopoly into potentially competitive sectors of the market. This paper has shown that the theoretically correct policy is mutual compensation at cost based rates and that mutual compensation alone is insufficient to limit monopoly power. A desirable interconnection policy should be closely related to the theoretically correct policy and also take account of the practical problems of administrative feasibility and of the definition and measurement of cost.

Several specific conclusions can be drawn from the analysis of this paper:

(1) If there are no regulatory controls on compensation for interconnection, the monopolist of part of the market can extend its monopoly power to the entire market;

(2) A mutual compensation policy without limits on the level of rates does not limit market power;

(3) The level of rates under a mutual compensation policy is unimportant if and only if the level of incoming and outgoing traffic is exactly balanced. Because traffic levels will rarely, if ever, be exactly balanced, the level of rates will be an important factor in the viability of competition;

(4) A mutual compensation policy with prices limited to the cost of service is the theoretically correct compensation policy. Mutual compensation with prices limited to the cost of service prevents the monopolist of part of the market from extending its market power to potentially competitive sectors of the market;

(5) Capacity charges rather than per minute charges allow attention to be focused on the cost of service at the peak load which is generally the real cost of service;

(6) "Sender keep all" is an administratively simple mutual compensation scheme with zero prices for terminating service. It is an attractive approximation to the theoretically correct policy of cost based prices when the incremental cost of terminating service is low.

APPENDIX

Brief Summary of Past Interconnection Compensation Efforts

Interconnection issues have played a crucial role in competitive viability and in pricing policy throughout the history of the telecommunication industry. Interconnection disputes began with the early efforts to expand market power in the telegraph industry through limits on interconnection rights and continued through the Bell companies' early twentieth century denial of interconnection to independent telephone companies, the development of legal rights to interconnection, the private line and CPE interconnection controversies of the 1970's, and the development and implementation of the access charge system during the 1980's.

The 1980 Computer II decision to remove CPE from Title II regulation included the decision to eliminate the support flows that had previously gone from CPE to other parts of the industry. Customers gained the right to interconnect any amount of CPE (so long as it met specified technical standards) to the public network with no specific interconnection charge. Customers still had to pay the tariffed local rates for service, but CPE was "carved off" from the public network. That decision was made in the context of a monopoly public network and a potentially competitive CPE component. Without the interconnection requirements, the monopoly local network provider could also monopolize the CPE, but with the requirements, the CPE market could develop in a competitive way independently of the actions of the monopoly local network providers.

It would have been possible to apply the CPE model to long distance interconnection (allowing the competitors to interconnect at ordinary local rates as MCI originally requested in its Execunet service), but that would have eliminated the established system of revenue flows from long distance to local service. The decision first to allow AT&T to impose the ENFIA tariff rather than local rates for long distance interconnection, and then the development of the access charge system, implied a desire to maintain the system of revenue flows from long distance to local service. The access charge system together with the MFJ restrictions on BOC participation in long distance service allowed the long distance market to develop competitively without interference from the local exchange companies, but did not force prices to the true cost of service as normally happens in a competitive market.

Both the CPE and long distance controversies occurred in a market structure in which one party (the local exchange) was assumed to have monopoly power and the other party (the CPE user or long distance provider) was assumed to operate in a competitive market. Thus the policy concern was to ensure that the competitor could receive access to the monopolized market at an appropriate price. The international model provides a more equal example in which both parties are assumed to have market power. So long as AT&T was the only U.S. carrier for international telephone traffic, it could bargain over the compensation scheme with monopoly entities in foreign countries on an equal basis. However, the beginning of competition in the U.S. for international calls increased the bargaining power of the foreign carriers. The foreign carrier was no longer restricted to dealing with AT&T for U.S. traffic but could agree to send traffic to the U.S. carrier that offered the foreign monopoly carrier the most favorable terms. This possibility created considerable concern at the FCC over whether the beginning of international competition in the U.S. would only benefit foreign carriers and not U.S. customers. Evan Kwerel's 1984 analysis of the international market concluded:

> This paper raises serious questions about the wisdom of deregulating U.S. international telecommunications without considering whether this will increase the market power of foreign telecommunications authorities. Increased competition among U.S. suppliers of international telecommunications services is likely to result in a reduction in the U.S.'s share of the benefits from such services unless the U.S. government takes appropriate countermeasures.[6]

The concerns raised in Kwerel's 1984 paper later developed into extensive FCC efforts to prevent monopoly foreign carriers from taking advantage of their unequal bargaining position with competitive U.S. carriers. The Commission found that equal payment in each direction was inadequate protection against manipulation for a monopolist of one side and sought to bring the rates paid for international terminating service down to the level of cost.

[6]Evan Kwerel, "Promoting Competition Piecemeal in International Telecommunications," FCC, OPP Working Paper 13 (December 1984), p. 49.

Incremental Cost Of Local Usage

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(Prepared for Cox Enterprises)

Summary

A reasonable estimate of the average incremental cost of local usage (and therefore the cost of terminating traffic received from a competitor) using digital technology is 0.2 cents per minute. That estimate is based on studies done by or supported by telephone companies. The cost is determined by peak period capacity and therefore the true cost is considerably higher than the 0.2 cents per minute average during the peak period and is zero during the non-peak period.

I. Introduction

In a separate paper prepared for Comcast, I have argued that the theoretically correct interconnection charge is cost based mutual compensation. However, cost can have many different meanings and in a regulatory context, cost based requirements can lead to interminable regulatory proceedings and disputes. Policy makers have consequently frequently sought structural methods of solving problems that do not require detailed oversight of cost rules.

One proposed structural rule is mutual compensation without oversight of actual rates, but as shown in the Comcast paper that approach is inadequate to limit the exercise of monopoly power. An alternative approach that dispenses with direct control of cost is the policy of "sender keep all" or "bill and keep" in which each party agrees to terminate traffic for the other without payment for terminating service. That is equivalent to mutual compensation with a zero price for compensation. It will be economically efficient if <u>either</u> of two conditions are met:

(1) Traffic is approximately balanced in each direction;
(2) The actual costs are very low so that there is little difference between a cost based rate and a zero rate.

Existing publicly available studies suggest that the incremental cost of local usage (and therefore the cost of terminating traffic from a competitor) is on average approximately 0.2 cents/minute. The actual cost is considerably higher during the peak period and zero during the off peak period. Thus it would not be efficient or desirable to charge at 0.2 cents/minute on a usage basis. However, the very low average number compared to the price currently charged by local exchange companies suggests that far greater distortions are likely from mutual compensation without control of rates than from sender keep all approaches.

There are two basic methods for estimating cost:

(1) engineering studies of the forward looking cost to supply a particular service;
(2) econometric (statistical) studies of the relationship between observed cost and observed outputs.

Both engineering and econometric studies provide useful information on cost. The engineering study allows one to focus on best practice technology and compute the incremental cost of adding capacity to provide a particular function. Econometric studies provide a reality check by using observed output and cost data rather than projections of expected cost. However, econometric studies may produce less precise estimates of the incremental cost of a particular service than engineering studies because they are measuring the correlation between variations in the total cost of different telephone companies and variations in the quantities of particular services provided by those companies. The cost data include costs for different embedded technologies used by the companies and are not precise enough to provide detailed estimates of the incremental costs of particular services with particular types of technology.

II. Engineering Estimate

The most comprehensive public engineering study of incremental cost was done by the Incremental Cost Task Force with members from GTE, Pacific Bell, the California Public Utilities Commission, and the RAND Corporation.[1] The Task Force had access to data for telephone companies in California and performed a detailed engineering cost study for various output measures of local telephone service. Individual components were priced based on 1988 prices and costs were computed for switch investment, switch maintenance, interoffice transport, and call attempt costs. All costs were computed for calls during the busiest hour of the year because the investment and associated expenses are related entirely to capacity cost. The Task Force computed the following usage costs for each hundred call seconds (CCS) during the busiest hour of the year for "average" and "larger urban" exchanges:

[1]Bridger M. Mitchell, Incremental Costs of Telephone Access and Local Use,(Santa Monica, CA: The Rand Corporation, 1990); reprinted in William Pollard, ed., Marginal Cost Techniques forTelephone Services: Symposium Proceedings (Columbus, Ohio: National Regulatory Research Institute, 1991) (NRRI 91-6).

switch investment	\$5.00 - \$10.00 per year
switch maintenance	.20 - .50 per year
interoffice calling	.50 - .60 per year
Total	\$6.00 - \$11.00 per year

In addition, the task force computed a cost of \$.30 to \$.90 per year for each call attempt during the busiest hour of the year and estimated approximately 1.25 busy hour attempts per busy hour CCS.[2]

There are 8766 hours per year and the ratio of the peak usage rate to the average usage rate is approximately 3.[3] That implies that one busy hour CCS is approximately equal to 2922 CCS per year (8766/3). Because one CCS is equal to 1.67 minutes, costs per busy hour CCS can be converted into average costs per minute by dividing by 4880 (2922 total year CCS times 1.67 minutes/CCS). Thus the \$6.00 - \$11.00 cost per year per CCS during the busiest hour of the year translates into \$.0012 - \$.0023 per minute. The busy hour attempt cost adds \$.375 - \$1.125 per busy hour CCS (1.25 busy hour attempts per buy hour CCS and \$.30 to \$.90 annual cost per busy hour attempt), raising the total cost, including busy hour attempts, to \$6.375 - \$12.125, and the per minute cost to \$.0013 - \$.0025. Taking the middle of the estimated range gives a cost of \$.0019 per minute, or approximately 0.2 cents/minute.

Because the cost is determined by the use peak capacity, the actual cost per minute is much higher at the peak and is zero at the off-peak. If, for example, one assumes that an equal size peak occurs for one hour in each business day (260 hours per year of peak usage and 8506 hours of non-peak usage), then the average cost per minute would be 2.1 cents for the 8.9 percent of the traffic that occurs during the 260 peak hours each year and the average cost per minute would be zero for the 91.1 percent of the traffic that occurs during the 8506 non-peak hours.

A variety of other engineering studies have been done for specific regulatory purposes and submitted to various state regulatory commissions. For example, New England Telephone prepared an engineering study for the Massachusetts PUC that found an incremental cost of 0.2 cents per minute for local usage served by electronic switches,

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[2]Ibid., p. 249, 250.

[3]Rolla E. Park, Incremental Costs and Efficient Prices with Lumpy Capacity: TheTwo Product Case, (Santa Monica, CA: The Rand Corporation, 1994). p.5.

the same as the Incremental Cost Task Force conclusion using California data.[4]

III. Econometric Estimate

Many econometric cost studies of telecommunications have been done, but the procedures used in most of them do not allow an estimate of the incremental cost of local service. One good econometric cost study that does provide an estimate of the marginal cost of local exchange service is the one performed in 1989 by Louis Perl and Jonathan Falk of NERA, using data from 39 companies (24 Bell and 15 non-Bell) over the years 1984-1987. They developed a statistical relationship between the total cost of the individual companies and the access lines, local usage, and toll usage provided by the companies.

Four different models were used for the statistical estimation. In two of the models, the data for each company was averaged over the four year period to eliminate the effects of minor year to year fluctuations and to provide a pure cross section estimate. In the other two models, observations were used for each company in each of the four years creating a mixture of time series and cross section observations. In two of the models, calls were used as the unit of usage measurement and in the other two calls minutes were used as the unit of usage measurement.

The estimated marginal costs for the local minutes ranged from 0.2 cents per minute to 1.3 cents per minute. The costs per call developed in the models using number of calls as the usage unit were divided by the average holding time to produce estimates of cost per minute comparable to those from the models using number of minutes as the usage unit. The lowest estimate came from the model with only cross section observations averaged over the four years. The highest estimate came from the model using all observations in a pooled cross section and time series and using calls as the unit of usage measurement. All four models had good statistical properties. Although there are various advantages and disadvantages of each of the four models, none of the four can be identified as either the clearly correct approach or an approach to be discarded.

The statistical form used by Perl and Falk generates marginal cost numbers approximately equal to average cost numbers. Thus it should be expected that their estimates will be somewhat higher than the engineering estimates of marginal or incremental cost. Furthermore, the engineering estimates generated by the Incremental Cost Task Force were developed based on digital switching technology while the Perl and Falk estimate for local minutes served by electronic switches was based on the embedded

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[4]Reported in Lewis J. Perl and Jonathan Falk, "The Use of Econometric Analysisin Estimating Marginal Cost," in Pollard, Marginal Cost Techniques., op cit.

technology in 1984-1987 which was primarily analog. It is likely that the incremental costs of usage capacity for analog switching are higher than the incremental costs of usage capacity for digital switching.

IV. Conclusion

A reasonable estimate of the average incremental cost of terminating traffic using digital switches is 0.2 cents per minute. That estimate is supported by the engineering studies done with data for California and for Massachusetts and by one of the econometric models developed by Perl and Falk. Other reasonable econometric models using embedded cost data produce somewhat higher cost estimates. The cost is determined by peak period capacity and therefore the true cost is considerably higher than the 0.2 cents/minute average during the peak period and is zero during the non-peak period.

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